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(54) Cam shaft manufacturing method and device used therein.

(57) A method of a device for manufacturing cam shafts, wherein rotatable rings (2) are provided for arranging cam members (15) in a predetermined angular relation to each other, prior to inserting a pipe (20) through the cam members, and fixing the cam members by expanding the pipe therein (the 'bulging' process).

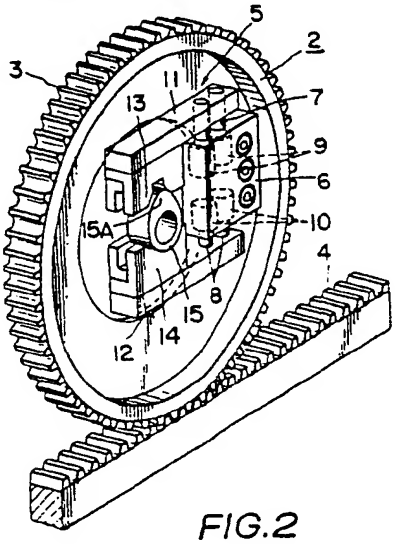

FIG.2

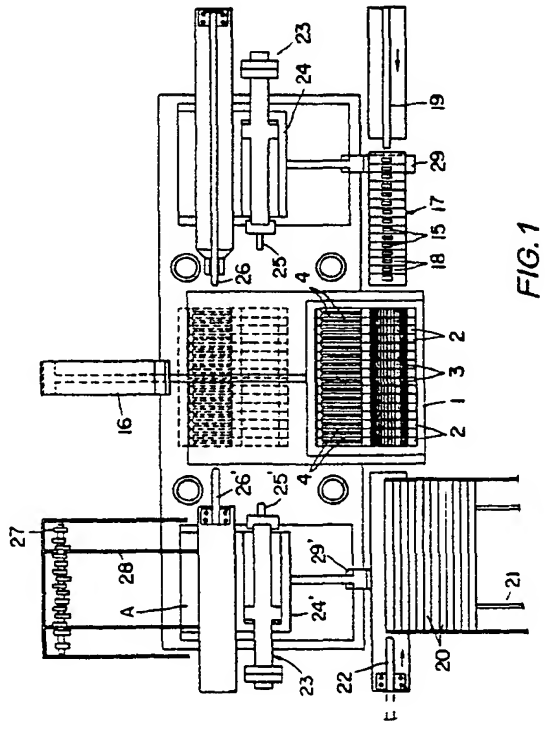

FIG.1

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CAM SHAFT MANUFACTURING METHOD AND DEVICE USED THEREIN

(Background of the Invention)

This invention relates to a method of manufacturing a cam shaft for use in an internal combustion engine for automobiles, motor cycles, and the like and to a device for use in such manufacture.

Related Art Statements

In the internal combustion engine of, for example an automobile, cam shaft are used to open/close valves intake/suction systems of cylinders at predetermined timing.

These cam shafts were heretofore manufactured by the casting or forging process which formed a cam, a journal, and a shaft integrally. Such cam shafts were therefore inevitably heavy in weight, presenting a bottleneck to reduction of the engine weight. In order to overcome the problem, there has been proposed a manufacturing device which is characterized in that engaging projection/recess members are provided opposite one another to determine the angle of each cam member so that the cam member can be manufactured to have a predetermined angular relation (Japanese Patent Application laid-open Sho 51-54115). In the proposed process, a shaft in the form of a hollow pipe has a cam member secured thereto, the cam member being secured on the exterior of the hollow shaft by a bulging process. The engaging projection/recess members are provided on respective cam members as well as on at least the lower die of the split dies which are used for holding the cam member during the bulging process.

However, the above device is disadvantageous in that it requires specific split dies with engaging members, and the structure of a split die is extremely complicated. Further, as the different type of engines required dedicated split dies, different split dies have to be prepared especially for all models which increases the costs.

There has also been proposed another in which a hollow shaft, which is shaped like a prism with a regular polygonal section, is fitted into a square hole of a cam member, the square hole of a cam member being formed in advance at a predetermined phase angle (Utility Model Publication Sho 53-7130).

However, the square holes of the cam members had to be formed with an extremely high precision in the proposed process, thereby presenting difficulities in the manufacturing process.

Objects and Summary of the Invention

This invention aims to obviate the problems encountered in the prior art, and to provide a method of manufacturing cam shafts and a device used therein, whereby cam shafts of various types can be manufactured without the need to form square holes at a high precision and without the need to use complicated split dies.

A method of manufacturing a cam shaft according the present invention comprises the steps of

(a) positioning a predetermined number of cam members relative to one another,

(b) transferring the cam members together to respective rotatable rings,

(c) securing each cam member to its respective ring by engaging the projection of the cam member in holding means carried by the ring,

(d) rotating the rings through predetermined angles so as to position the cam members in a predetermined angular relationship to one another,

(e) introducing a pipe member into corresponding holes formed in the cam members, and,

(f) sealing both ends of the pipe member and forcing pressurized fluid into the pipe member so as to expand the pipe member so fixing the cam members on the outer peripheral surface of the pipe member by the bulging process.

Preferably the cam members are supported for conveying to said rings by a rod inserted through the holes of the cam members, the rod being moved, to carry the cam member therewith in the direction of the axis of the rotatable rings.

Conveniently the holding members having recessed and sloped surfaces in the form of letter V.

Desirably the step of rotating the rotatable rings through predetermined angles comprises the steps of engaging gear teeth on the outer peripheries of the rings with racks, and moving the racks through predetermined distances.

Preferably the holes of the cam members are grooved.

The invention further resides in a device for manufacturing cam shafts, the device comprising a plurality of rotatable rings, holding means for the cam members carried by the rotatable rings, which can approach or recede from the projections of the cam members, rotating means for rotating said rings individually through a predetermined angle, and a bulging process device which can seal both ends of the a pipe member inserted into the hole of each cam member held by the holding means, and force pressurized fluid into the pipe.

Desirably there is provided a conveying means

for conveying cam members to said rings, said means including a rod movable axially to carry cam member from a position adjacent the rings to engage in the holding means of the rings.

Preferably the outer diameter of the rod of the cam member conveying means can be inceased.

Conveniently the holding means for the cam members have recesses with slopes formed like letter V.

Conveniently said rotatable rings are carried on a movable base.

Preferably the rotating means for rotaing said rings comprises gear teeth on the outer peripheries of the rings and racks which engage with the gear teeth, the racks being slidably movable to rotate the rings.

Brief Description of the Drawings

In the accompanying drawings;

Figure 1 is a plan view of an embodiment of a device for use in the manufacture of cam shafts according to this invention;

Figure 2 is a perspective view to show a rotating ring show in in Figure 1;

Figure 3 is an enlarged perspective view showing the holding section of a holding means for cam members;

Figure 4 is a longitudinal section thereof;

Figure 5 is a frontal view of an example of the cam member; and

Figure 6 is a frontal view of a modified example of the cam member.

Detailed Description of Preferred Embodiments)

The invention will now be described in further detail referring to the embodiments shown in attached drawings.

Figure 1 shows an example of the arrangement of each component part suitably arranged for practical operation wherein a plurality of rotatable rings 2 are aligned coaxially on a base 1. The rings 2 each have gear teeth 3 on the outer periphery thereof in the embodiment illustrated so that they can engage racks 4 which are slidably mounted on the base 1.

Cam member holding means 5 is mounted inside each of the rings 2 in a manner that the holding means can synchronously rotate with its respective ring 2. As shown in Figures 2 through 4, the holding means 5 comprises a block 6 fixed inside the rotating ring 2, fluid cylinders 9, 10 provided inside the fixed block 6 and piston rods 7, 8 movable parallel to one another but in opposite directions, supporting arms 11, 12 which are connected to said rods 7, 8, and extend perpendicular thereto and holding members 13, 14 which are provided on the opposed faces of supporting arms 11, 12.

The holding members 13, 14 are formed with recesses in the form of letter V with sloped surfaces 13A, 14A so that they can firmly hold a projection 15A, and a circumferential surface opposite to the projection 15A, of a cam member 15. When the projection 15A of the cam member is held therein, the two sides of the projection can be positioned in laterally symmetrical positions with the sloped surfaces 13A, 14A to achieve alignment of the center of the projection 15A with the center of the holding member 13.

The base 1 can be moved from the position shown in full lines in Figure 1 to the position shown in broken lines by a driving means such for example as air cylinders 16 or piston rods.

A table 17 is installed in axial alignment with the ring 2 and at one side of the base 1, for setting the cam members. On its upper surface the table 17 is formed with cam member mounting sections 18 each in the form of a recess for vertically mounting a cam member 15. Such that the cam members are supported individually and at a predetermined spacing.

By arranging the cam members 15 on the section 18 with the projections thereof facing upward, the cam members can singly be arranged to have their holes 15B in axial alignment.

On the side of the table 17 opposite the rings 22 is provided a feeding rod 19 for the cam members. The rod 19 can be moved (in the direction indicated by an arrow) by a driving means (not shown) such as fluid cylinders to penetrate the holes 15B of the cam member 15. The rod 19, which is not illustrated in detail, should preferably be structured so as to be able to grip the cam members 15, for example by being expandable so that the outer diameter thereof can grip the walls of the holes 15B.

On the opposite side of the base 1 from the table 17 are provided a chute 21 for supplying pipe members 20 which form shafts to fthe cam shafts, and a pipe forcing rod 22 which is installed at one end of the chute 21 to force a pipe member 20 into the holes 15B of the cam members 15. Which the cam members are being supported by the holding means 5, of the rotating rings 2 the pipe member 20 being axially aligned with the holes 15B. On both sides of the base 1 are provided bulging process devices 23, parallel to the table 17, for fixing said cam members.

Similarly to the prior art devices, the bulging process devices 23 comprise a pair of cylinders 24, 24', and upper and lower holding dies (not shown), and are structured to have the ends of

rods 25, 25' of the cylinders 24, 24' closely attached onto the ends of the pipe members 20 inserted through the cam members 15 so that fluid (e.g. water) can be forced into the pipe members 20 through fluid paths (not shown) of the rods 25, 25'.

Product outlet rods 26, 26' are installed adjacent to the bulging process devices 23 to oppose each other across an adjustable space so that they can hold both ends of a complete cam shaft and move the cam shaft 27 to a discharging position A.

At the positive A is installed a receiving table 28 to receive cam shafts 27 as they are discharged.

The reference numerals 29, 29' denote cylinders which move the product outlet rods 26, 26' and the bulging process devices 23.

A method of manufacturing cam shafts using the device which is structured as above will now be described. Pipe members 20 are supplied on the chute 21, and cam members 15 are placed with their projections 15A facing upward on the sections 18 of the table 17.

Then, the feeding rod 19 is advanced to the left (in Figure 1) to penetrate the holes 15B of the cam members 15 arranged on the table 17, and the diameter of the rod 19 is increased to thereby firmly hold the cam members 15.

Next, the rod 19 is advanced further to the left so as to move respective cam members 15 to the holding means 5 of the corresponding rings 2.

Each cam member 15 is automatically positioned by the alignment of the projection 15A with the sloped portions 13A, 13A of the holding member 13, as the members 13, 14 close on the cam member which is thus held from above and underneath. The diameter of the rod 19 is then reduced, and the rod 19 is pulled out of the holes 15B of the cam members to leave the cam members, 15 in a state where by are held firmly with the holding means 5 of respective rings 2.

The rings 2 are now rotated through predetermined angles so that the projections 15A have a predetermined angular relation to each other. The rings 2 can be rotated by moving the racks 4 with which the gear teeth 3 on the peripheries of rings are engaged. More particuarly, by moving respective racks 4 the rotating rings 2 are rotated via the gear teeth 3, and the cam members 15 which are held by the holding means 5 are rotated synchronously to thereby adjust the angular relationship between cam members 15.

As the number of gear teeth on the rings 2 in this embodiment is 64, the rings can be rotated by ca. 5.6° per pitch. If the number of gear teeth is 120° the rings can be rotated by 3°. Naturally, if the backlash between the gear teeth 3 and the rack 4 is diminished, the rotation of the rings can be through an angle smaller than 3°.

After adjusting the angular relation of the cam members 15 the rod 22 is advanced to the right (in Figure 1) and a pipe member 20 at the end of chute 21 is inserted to penetrate the holes 15B of the members 15.

After the insertion of the pipe 20, the base 1, carrying the rings 2, is moved to the position shown in broken lines in Figure 1 by actuating the cylinder 16, and thereafter the cylinders 24, 24' of the bulging process devices 23 are actuated, and the rods 25, 25' are forcedly attached on the ends of the pipe member 20. The pipe member 20 is supported between the cam members by engagement of those portions of the pipe member 20 which are not in contact with the cam members, in metal dies or moulds (not shown).

Next, fluid is forced into the pipe member 20 from the rods 25, 25' via fluid paths (not shown) to bulge the pipe 20 outwardly against the inner peripheral surfaces of the holes 15B of the cam members 15, thereby fixing the cam members 15 on the pipe members 20.

After fixing the cam members 15, the pipe members 20 are released from the holding means 5 and the metal dies or moulds, the rotating rings 2 are moved to the position of the product outlet rods 26, 26', the rods 26, 26' are advanced to hold both ends of the pipe member 20, and then are moved to the outlet position A to release the pipe 20, and the completed cam shaft 2 is discharged to the receiving table 28.

Then rotating rings 2 are moved downward (in the figure 1) to repeat the aforementioned steps in the manufacturing process for the cam shafts 27.

In fixing said pipe member 20 to the cam members 15, if recesses 15C are formed beforehand on the inner peripheral surfaces of the holes 15B corresponding to the projections 15A so that the pipe 20is deformed and forced into the recesses 15C, by the fluid pressure, then the pressure of the fluid could be reduced to a certain extent in the bulging process.

Although not illustrated, a large number of grooves may be formed axially either on the outer peripheral surface of a pipe 20 or the inner peripheral surface of the holes 15B, or the holes 15B per se may be formed polygonal to improve the securing of the cam member to the shaft.

As shown in the drawings, gear teeth 3 may be provided on the outer periphery of a ring 2, and the ring 2 may be rotated by moving a rack 4 thus attaining a precise rotational angle easily. If a stop arrangement is associated with the rack 4 the stopping position of the ring 2 may be controlled very conveniently.

It should be recognised that other means for rotating the rings 2 can be utilized if desired.

If extremely high precision is required in the manufacture, a rotary table which can rotate the rings in 0.1° increments should be used.

As described in detail in the foregoing statement, the manufacturing method and the device to be used therein can adjust and set phase angles between cam members simply by rotating the rotatable rings. Thus cam shafts suitable for all types of engines can be produced using the same device and the invention can thus be applied in a wide varierty of fields.

This invention method and device do not need complicated split dies nor forming at a high precision a polygonal hole in a cam member, thereby enhancing workability and reducing the cost of process.

Claims

1. A method of manufacturing a cam shaft charactorized by comprising the steps of;

(a) positioning a predetermined number of cam members (15) relative to one another,

(b) transferring the cam members (15) together to respective rotatable rings (2),

(c) securing each cam member (15) to its respective ring (2) by engaging the projection (15A) of the cam member (15) in holding means (13, 14) carried by the ring,

(d) rotating the rings (2) through predetermined angles so as to position the cam members (15) in a predetermined angular relationship to one another,

(e) introducing a pipe member (20) into corresponding holes (15B) formed in the cam members, and,

(f) sealing both ends of the pipe member (20) and forcing pressurized fluid into the pipe member so as to expand the pipe member so fixing the cam members (15) on the outer peripheral surface of the pipe member (20) by the bulging process.

(2) A method of manufacturing a cam shaft as claimed in claim 1 charactorized in that the cam members (15) are supported for conveying to said rings by a rod (19) inserted through the holes (15B) of the cam members, the rod (19) being moved, to carry the cam member (15) therewith in the direction of the axis of the rotatable rings (2).

(3) A method of manufacturing a cam shaft as claimed in claim 1 or claim 2 charactorized by the holding members having recessed and sloped surfaces in the form of letter V.

4. A method of manufacturing a cam shaft as claimed in anyone of claims 1 to 3 charactorized in that the step of rotating the rotatable rings (2) through predetermined angles comprises the steps of engaging gear teeth (3) on the outer peripheries of the rings (2) with racks (4), and moving the racks (4) through predetermined distances.

5. A method of manufacturing a cam shaft as claimed in anyone of claims 1 to 4 charactorized in that the holes (15B) of the cam members (15) are grooved.

6. A device for manufacturing cam shafts charactorized by comprising a plurality of rotatable rings (2), holding means (13, 14) for the cam members (15) carried by the rotatable rings (2), which can approach or recede from the projections (15A) of the cam members, rotating means (3, 4) for rotating said rings individually through a predetermined angle, and a bulging process device (23) which can seal both ends of the a pipe memb r (20) inserted into the hole (15B) of each cam member held by the holding means, and force pressurized fluid into the pipe.

7. A device as claimed in claim 6 charactorized by a conveying means for conveying cam members to said rings, said means including a rod (19) movable axially to carry cam member from a position adjacent the rings to engage in the holding means of the rings.

8. A device as claimed in claim 6 or claim 7 charactorized in that the outer diameter of the rod (19) of the cam member conveying means can be inceased.

9. A device as claimed in anyone of claims 6 to 8 charactorized in that the holding means (13, 14) for the cam members have recesses with slopes formed like letter V.

10. A device as claimed in anyone of claims 6 to 9 charactorized in that said rotatable rings are carried on a movable base.

11. A device as claimed in anyone of claims 6 to 10 charactorized in that the rotating means for rotaing said rings comprises gear teeth (3) on the outer peripheries of the rings and racks (4) which engage with the gear teeth (3), the racks (4) being slidably movable to rotate the rings (2).

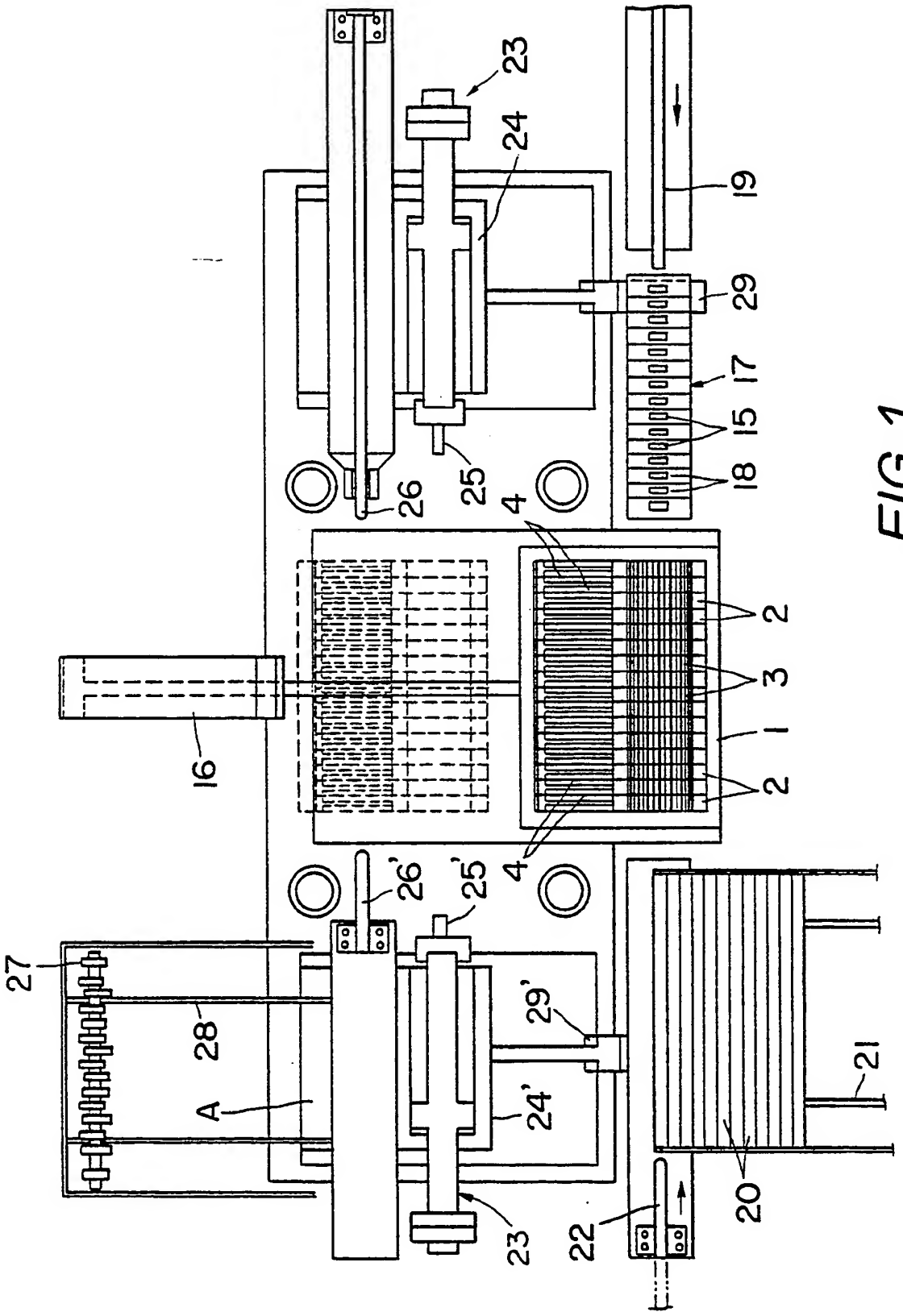

FIG. 1

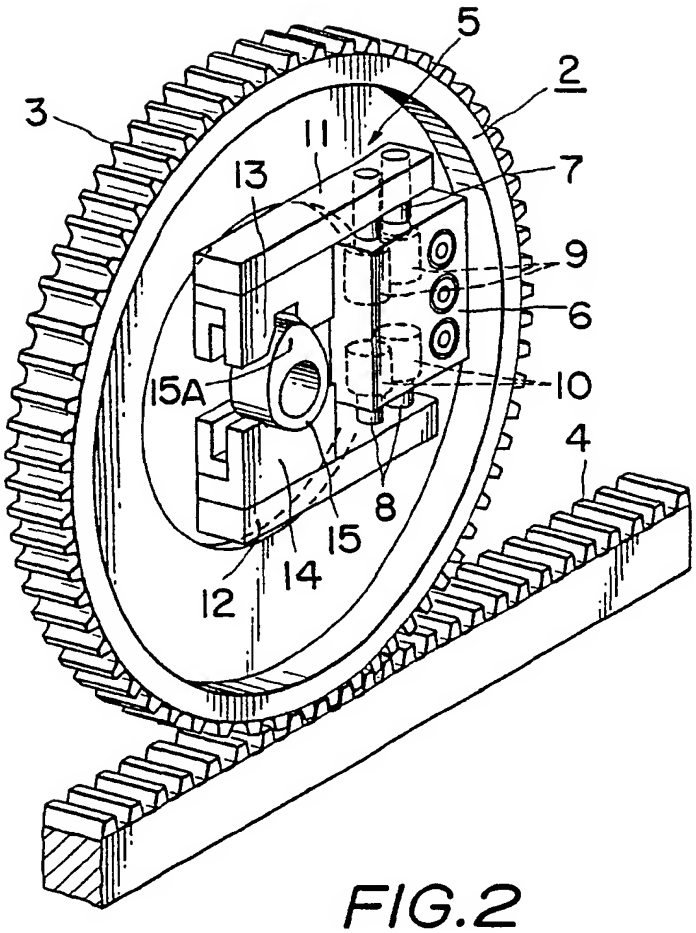

FIG.2

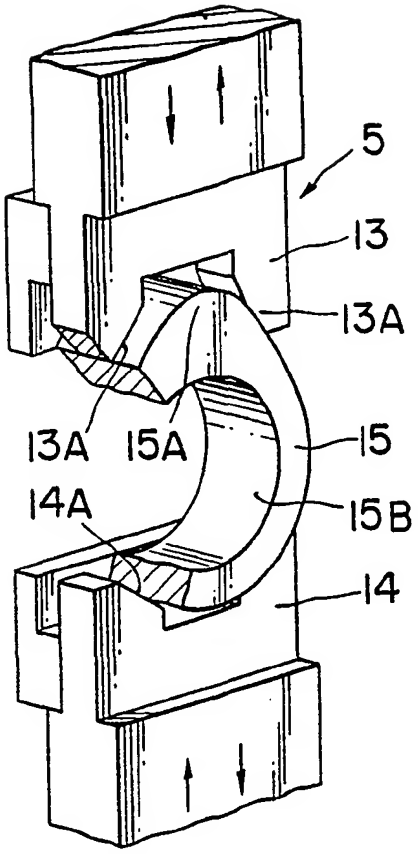

FIG.3

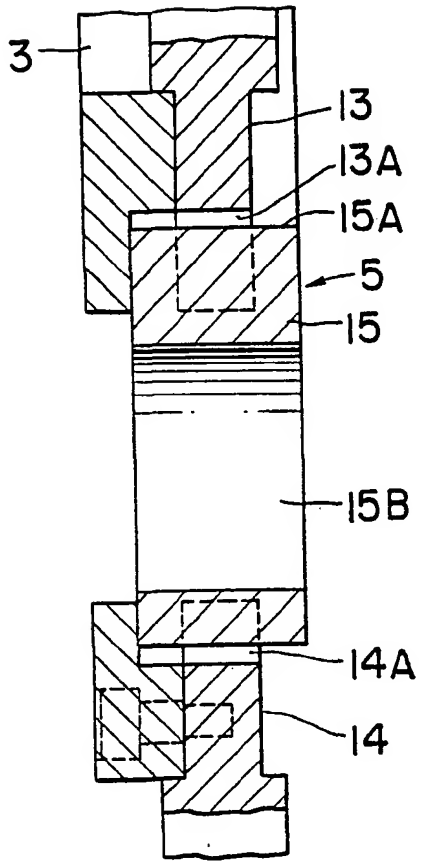

FIG.4

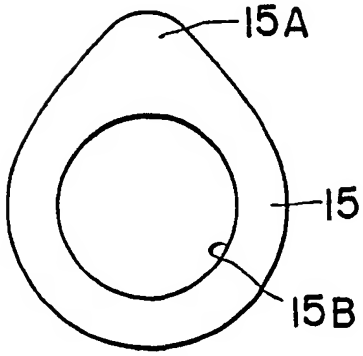

FIG.5

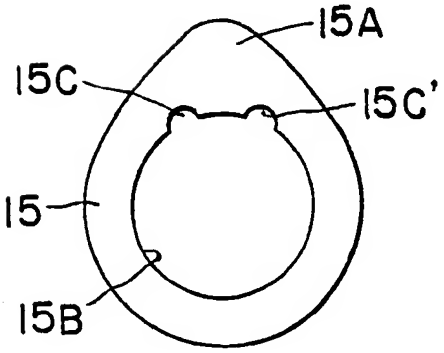

FIG.6

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EUROPEAN SEARCH REPORT

Application Number

EP 88 30 0931

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	DE-A-3 227 693 (MAHLE) * Page 6, lines 30-36; figures 1,2 *	1,3,6,9	F 01 L 1/04
A	EP-A-0 190 841 (GENERAL MOTORS) * Page 5, lines 17-35; page 7, lines 1-11; figure 5 *	1,2	
A	DE-A-3 431 361 (AUDI) * Page 7, line 1 - page 8, line 12; figures 1-4 *	1,2	
P,A	EP-A-0 230 731 (HUGHES) * Column 4, lines 1-49; column 6, line 47 - column 7, line 54; figures 1-5 *	1,2	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

F 01 L
F 16 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-05-1988	LEFEBVRE L.J.F.

CATEGORY OF CITED DOCUMENTS

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